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APPLICATION FOR UNITED STATES LETTERS PATENT

EXERCISE MACHINE

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BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to exercise machines, and in particular to an exercise machine that provides continuous load exerting resistance for the user.

2. Prior Art

Exercise machines that utilize bicycle like motion for hands and feet are well known in the art. Such machines suffer the drawback that the action is pedal-like in that one arm pushes while the other pulls and vice versa. This action does not provide continuous resistance for each of the pushing and pulling actions, and as such results in an undesirable exercise regiment.

SUMMARY OF THE INVENTION

The invention provides an exercise machine which includes a support structure, a resistance assembly which is connected to the support structure, a drive member with an output point from which force is applied to the resistance assembly and an input point which is spaced from the output point by a distance L, and at least one handle which acts on the drive member at the input point and

which a user can engage and move in a continuous, load-exerting manner, against a resistance force which is generated by the resistance assembly.

"Continuous, load-exerting" means that the movement of the handle is such that at all times the user is capable of exerting force on the handle to move the drive member against the resistance force. This is to be contrasted with a bicycle-type movement which is encountered in a machine of the type which has support structure with outwardly extending cranked handles on opposed sides of the structure which are moved in alternating or reciprocating movement by a user. With this type of machine the design is such that the user alternately pushes with one arm while pulling with the other arm, and vice versa.

The machine may have one handle with which one hand of user is engageable. Alternatively the handle may be such that two hands of the user are engageable therewith. In another variation the machine has two handles with which two hands of the user are respectively engageable.

In a preferred form of the invention the user's arms act in unison on the handle or handles, against the resistance force.

The expression "acting in unison" is intended to include a movement of the user's arms, whereby the user's arms move substantially in the same way and at the same time as each other. Thus both arms act against the resistance force at the same time. This is to be contrasted with the type of movement, encountered for

example on the bicycle-type machine referred to, in which the user's arms move with a pedal-type motion in alternating fashion with one arm pulling and the other arm pushing, and vice versa.

The input point, when moved by the handle, may move along a path which may form a closed loop of any appropriate shape or which may be variable dynamically ie. as the user works on the handle. It is preferred however that the path of movement is defined and forms a closed loop of circular shape.

The path of movement of the input point preferably lies in a substantially vertical plane. It is possible though for the path of movement to lie in a substantially horizontally plane, or in an inclined plane, or for the path of movement to be non-planar. For example, if the input point moves laterally relative to the support structure, which may be upwardly extending, then the path of movement, even if it forms a closed loop may not lie in a plane but could follow a convoluted three-dimension path.

As indicated though it is preferred for the path of movement to lie in a vertical plane for this allows the user to stand on one side of, and adjacent, the plane, away from the support structure. This feature makes it possible for the user to move fully and freely, and obtain maximum benefit from the machine for many parts of the body.

To enable the user's arms to act in unison on the handle, the exercise machine must be dimensioned and structured so that no part thereof interferes with the body of the user. To achieve this objective the support structure preferably extends upwardly and the handle is on one side of the support structure only.

The support structure may include a base which is attachable to the floor to stabilise the exercise machine during use thereof.

In an alternative arrangement, the support structure includes formations whereby the support structure is attachable to a wall to stabilise the exercise machine during use thereof.

In a preferred embodiment however the exercise machine includes a base which is attached to a lower end of the support structure and which provides a platform upon which the user stands so that the user's mass stabilises the exercise machine during use thereof.

The length of the drive member between the input point and the output point may be adjustable to vary the distance L.

The drive member may be adjustable against a biasing element such as a piston and cylinder arrangement, a spring, an elastic member such as a rubber band or the like, a worm-type device, and so on. The use of a biasing element which may, itself, be adjustable to provide a variable biasing force, enables the input

point to move along a path of variable shape. It is possible to make use of control means, eg. an automatically controlled actuator or motor to adjust the length of the drive member, to provide a controlled variation in operating characteristics of the machine.

On the other hand the drive member may be adjustable according to requirement to set the distance L at a defined length. A releasable fastener, which acts on the drive member once it has been adjusted, may be used to prevent the distance L from varying during use of the exercise machine.

The drive member may be rotatable by the handle about the output point.

The handle may take on a plurality of different forms. In one example of the invention the handle includes grips for the user's hands, the grips being positioned so that the hands, when engaged with the grips, extend around a common axis which is transverse to the path of movement of the input point. With this form of the invention the grips are preferably positioned side by side and the handle may, for example, comprise an elongate shaft of sufficient length to ensure that portions of the shaft which are adjacent each other define grips for the user's hands.

The shaft, which defines the handle, may extend from the drive member at the input point and may be rotatable about an axis which is centered on the input point. It is also possible though, alternatively or in addition, to provide rotatable

grips on the shaft so that the grips rotate about the shaft during movement of the drive member by a user.

In a different form of the invention, the handle includes grips for the user's hands which are positioned on respective opposed sides of an input axis which is transverse to the path of movement of the input point and which extends through the input point. This arrangement allows the user to face a plane in which the input point is moved during use of the exercise machine ie. in which the closed loop lies. With this arrangement the user effectively turns through 90^{O} compared to the position which the user occupies with the first mentioned handle arrangement.

With the latter handle arrangement the user's arms are again used in unison but with a circular type motion which is transverse to, and in front of, the user's body during use of the exercise machine.

Different handles may be provided for a single machine and a user may select a handle type, as required, for different types of exercises.

The handles may allow for the orientation of the grips, relative to the input axis, to be varied in use. This feature reduces the strain which could otherwise be placed on a user's hands and arms during use ie. while causing the input point to rotate, along a path of movement, about the output point. For example, the handle, or the grips, may be connected to the input point through a universal

joint, a ball joint, a spring or rubber connector, or any similar device which allows relative pivotal movement between the grips and the input point, but which still allows a drive force to be applied from the grips to the input point.

The path may have a highest point which is a distance X above a ground reference level on which the user stands and a lowest point which is a distance Y above the ground reference level and wherein X $\geq$2Y. By adjusting the distance L it is possible to make X substantially greater than 2Y.

By adjusting the ratio of X to Y, the degree to which a user must bend and extend upwardly when moving the handle so that the input point moves along the path, can be significantly varied.

The support structure, as indicated, can take on a plurality of different forms. However to enable the support structure to be provided in a manner which can be put into a compact mode for storage and transport purposes, it is preferable for the support structure to have at least two upwardly extending inclined supports with the resistance assembly being mounted to the supports, preferably to upper ends thereof.

Use may be made of a base which interconnects lower ends of the supports and which forms a platform upon which the user stands.

The supports may be pivotally movable towards each other for storage and transport purposes, and away from each other to place the machine in an operative mode. The base may include a plurality of pivotally interconnected panels which are moved in a corresponding way in unison with the supports.

The output point may be near the upper ends of the supports and the resistance assembly may include a flywheel which is rotatable about an axis which extends through the output point. Alternatively the exercise machine may include a drive arrangement which is connected to the output point and which transfers motion to the flywheel. The drive arrangement may include a gearbox or gear train, a system of belts and pulleys, or any similar drive transferring system which causes the rotational speed of the flywheel to be related in a desired ratio to the rotational speed of the output point. This increases the force which is generated by the resistance assembly and against which the user acts.

In a preferred example of the invention, the path of movement of the input point is a circle and the drive arrangement is such that the ratio of the rotational speed of the flywheel to the rotational speed of the output point is greater than 20. It has been found through experimentation and trial and error that this ratio and higher values, eg 25, are particularly effective in that these ratios enable the flywheel to have a relatively small mass (e.g., of the order of 5kg (12.5lbs)), while still providing sufficient resistance force to a user who can cause the input point to move at a comfortable speed along the defined path. It is evident that the ratio

of the rotational speed of the output point to the rotational speed of the flywheel, as given by the aforementioned ratio, and the mechanical advantage obtainable, inter alia, by the distance L, help to determine the resistance force which is developed and presented to the drive member. There is a compromise between the momentum developed by the flywheel which helps to give a smooth movement to the handle, reducing the effect of "dead spots", a feature (ie. smooth movement) which generally is more pronounced as the mass of the flywheel increases, and the size and mass of the exercise machine as a whole.

The resistance force may be varied by making use of a brake which acts on the flywheel and which is adjustable thereby to exert an adjustable braking force which restrains rotational movement of the flywheel.

The brake may be in the nature of a belt brake, a friction brake, an electromagnetic brake, a magnetic brake, or any equivalent component. The invention is not limited in this regard. The brake may be controlled automatically, eg. by means of suitable control electronics, to vary the braking force to suit the user, for example in a dynamic fashion. It then becomes possible to vary the path of movement of the input point and the resistance force in a controlled manner.

If drive is to be imparted by the handle to the resistance assembly, and not in the reverse direction, the exercise machine may include a uni-directional drive device between the handle and the resistance assembly. The drive device may be

switchable or operable to change the direction (in a rotational sense) in which drive is imparted to the resistance assembly by the handle.

The uni-directional drive device may be in the nature of a ratchet device but any equivalent arrangement can be used. The invention is not limited in this regard.

A smooth, sweeping-type action can however be obtained if the handle is permanently connected to the flywheel, ie. if no uni-directional device is used, for the flywheel's momentum drives the handle through dead spots which could occur at extremities of the path of movement, and a continuous input of force is required of the user via the handle. It is imperative though for the resistance force, the mass of the flywheel, the radius of movement of the handle and the relationship between the rotational speed of the handle and the rotational speed of the flywheel to be carefully inter-related to ensure that the handle can be moved at a steady speed, which is not too fast to unbalance a user, against a resistance force of sufficient magnitude to provide a safe and effective workout.

In a preferred form of the invention, the exercise machine includes a base which, in use, provides a platform for a user, a support structure which extends upwardly from the base, a drive member which has an input point and an output point and which is connected to the support structure, a resistance assembly which is connected to the output point, and a handle connected to the input point whereby a user, on the platform, can grip the handle with two hands and rotate

the handle about the output point against a resistance force which is generated by the resistance assembly.

The drive member may be of adjustable effective length to vary the distance between the input point and the output point, the drive member being rotatable about an axis which passes through the output point, and the resistance assembly may include a flywheel which is rotatable by rotational movement of the drive member. A drive arrangement may be connected between the output point and the flywheel to transfer drive to the flywheel at a suitable mechanical ratio.

The support structure may include upwardly extending supports which are pivotally movable relative to each other and the base may include a plurality of panels which are connected to lower ends of the supports. The resistance assembly may be attached to at least one of the supports and the base may be positioned on a side of the supports so that a user, on the base, is alongside the support structure and does not "straddle" the support structure, as is the case with the bicycle-type arm exercise machine previously referred to.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described by way of examples with reference to the accompanying drawings in which:

Figure 1 is a side view of an exercise machine according to one form of the invention;

Figure 2 shows the use, in different combinations, of two machines each of which is substantially the same as what is shown in Figure 1;

Figures 3, 4 , 5 and 6 are respectively a side view, an end view, a plan view and a view in perspective, of an exercise machine according to another form of the invention;

Figures 7 to 10 respectively correspond to Figures 3 to 6 and show the machine of Figures 3 to 6 in a collapsed or storage mode;

Figure 11 shows another exercise machine according to the invention;

Figures 12 to 16 illustrate different methods of adjusting a rotational path which a user's hands follow when using the exercise machine of the invention;

Figures 17 to 23 show different handles which can be used with the machine of the invention;

Figures 24 and 25 illustrate two of the handles in use;

Figures 26 and 27 show a machine according to the invention fixed to a floor and a wall respectively;

Figures 28 to 30 illustrate different arrangements of the exercise machine of the invention; and

Figure 31 shows the use in combination, from one end, of two machines each of the kind shown in Figures 3 to 6.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 of the accompanying drawings illustrates an exercise machine 10 according to a first form of the invention.

The machine 10 includes a base plate 12 which is mounted to an upwardly extending support column 14 which has a drive shaft 18 mounted, near opposed ends, to bearings 20 and 22 respectively. A relatively large drive pulley 24 is fixed to the drive shaft slightly above the bearing 20.

A bevel gear 26 is fixed to an upper end of the drive shaft.

A cranked member 28 which includes a stub axle 30, a lever 32 and a handle 34, is fixed to an upper end of the support column 14. The stub axle extends horizontally, is mounted to bearings 36 and 38, and is centred on an axis A which defines an output point to components which form a drive arrangement in the machine. A bevel gear 40, which mates with the gear 26, is fixed to the axle. At a position between the bevel gear 40 and the bearing 38 an optional one-way drive mechanism in the nature of a ratchet 42 is installed. The arrangement is such that rotational drive can be transferred from the lever 32 to the gear 40, in one direction, but drive cannot be transferred from the gear 40 to the lever 32.

The mechanism, if used, can be switched to change the direction in which drive is transferred between the lever and the gear.

The handle 34 may be movable along the length of the lever 32 or the lever 32 can be adjusted relatively to the stub axle 30, so that the position of the handle 34 can be adjusted relatively to the axle to a selected position shown in dotted lines 34X.

A thrust bearing 50 is mounted to the base plate. An axle 52 extends upwardly from the thrust bearing and a flywheel 54 is mounted to the axle. At its upper end the axle 52 is supported by means of a bearing 56.

A pulley 58 is mounted to the axle above the upper surface of the flywheel and below the bearing 56. A belt 62 couples the drive pulley 24 to the pulley 58.

A brake 66 is engaged with the flywheel 54. The brake is adjustable to constrain rotational movement of the flywheel 54 about the axle 56 to a greater or lesser extent. In this example the brake is a magnetic device of a kind which is known in the art. Any other type of brake could be employed, for example a belt which is engaged with the flywheel, a friction roller which bears on a rim of the flywheel, an electromagnetic brake, or the like. The invention is not limited in this regard.

A cover 70 overlies the flywheel and the pulley 24 and provides a platform upon which a user, not shown, can stand while using the exercise machine. In use of

the machine the user's weight provides a ballast, or stabilising effect, which helps to keep the machine steady.

The exercise machine 10 can be used in different ways. In one form of use the handle 34, which forms an input point to the machine, is sufficiently lengthy so that a user, who stands on the cover, can grip the handle 34 with both hands, one adjacent the other. The height of the axle 30 above the platform 70 and the length of the lever 32 (between the handle and the stub-axle) are such that, as the user rotates the lever about the axle 30, the user must, at some stage, bend at the knees and, subsequently, move the arms from a lower position to an upper position. As the lever 32 is rotated, rotational drive is transferred to the drive shaft 18 and drive is imparted by the drive pulley 20 and the belt 62 to the driven pulley 58. The flywheel is thereby caused to rotate against a braking effect exerted by the magnetic brake 66. The brake can be adjusted to provide more or less resistance, according to requirement, to the rotational movement of the flywheel. The ratios of the various gears and pulleys in the drive arrangement from the axle 30 to the flywheel 54 determine the mechanical advantage between the handle and the flywheel, a factor which helps to set the resistance force which is developed.

The exercise machine causes the user to exercise at least his legs, his arms and his upper torso while rotating the handle.

In a variation of the invention, the user, standing on the platform 70, grips the handle 34 with both hands while facing the column 14 as opposed to facing in a direction which is at a right angle to the stub axle 30, as is the case in the former mode of use. The user rotates the handle 34 using both hands, which move in unison, with a squatting and lifting type of body action.

In each mode of use the path of movement of the input point, formed by the handle 34, is a closed loop of circular shape which lies in a vertical plane, and the user is either positioned adjacent the plane, facing in a direction which is generally parallel to the plane, or is positioned facing the plane, orientations which do not arise when use is made of a bicycle-type machine.

Figure 2 illustrates an exercise machine 80 which includes, in combination, a first machine 10 of the kind described in connection with Figure 1 and a second machine 10A which is fundamentally the same as the machine 10 and which is erected on a support column 16. Components of the machine 10A which are the same as components of the machine 10 are not described in detail and bear like reference numerals with the suffix "A".

Although the machine 10A could have a separate flywheel, in this example only one flywheel is used and the output drive of the machine 10A is connected to the flywheel 54 by means of a pulley 60 which is mounted to the axle 52 below the bearing 56, and a belt 62A which couples the drive pulley 24A to the pulley 60.

The handle 34 can be coupled directly to the handle 34A using a connector 82 which is shown in dotted outline. This means that the members 28 and 28A are movable in unison.

If the handles 34 and 34A are not directly connected the angular separation between the handles can be varied to any appropriate extent between 0^{o} and 180^{o}. Figure 2 shows (in dotted lines for the handle 34A) the handles separated by about 180^{o} with a gap 84 between the handles which is occupied by a user. Again the path of movement of each input point (defined by each handle) is parallel to the direction in which the user faces.

Figures 3 to 6 illustrate an exercise machine 90 according to another form of the invention from the side, from the end, in plan, and in perspective, respectively.

The machine includes support structure 92 in the form of two elongate, inclined, upwardly extending supports 94 and 96 respectively which are pivotally connected to each other at upper ends 98, directly or by means of intermediate structure such as a flywheel housing 99, in a way which allows the supports, within reason, to be pivotally moved towards, and apart, from each other.

The machine includes a base 100 which rests on the ground and which, in use, provides a platform, upon which a user, not shown, can stand while using the machine. In this example the base 100 includes three panels 102, 104 and 106 respectively which are pivotally connected to one another at points 108A and

108B in a planar array. The base is fixed to lower ends of, and braces, the supports 94 and 96.

A compact flywheel 110, within the housing 99, is mounted to the support structure near the upper ends of the supports 98. The flywheel is driven by a small drive mechanism 111 which is directly fixed to an axle 112 and ends of the axle are accommodated in bearings 113 secured to the upper ends of the supports 94 and 96. The flywheel is relatively compact and weighs approximately 5kg. It has been found through trial and experiment that a flywheel of this type is adequate for the purposes of the invention in that it is capable of providing sufficient resistance and a required degree of momentum, when used in the manner described hereinafter, but at the same is not unduly heavy or massive, a feature which enables the flywheel to be mounted to the upper ends of the supports.

A brake 114 is used to provide a controlled restraining force which impedes free movement of the flywheel. The brake 114 may be of any appropriate kind eg. a magnetic or an electromagnetic brake which is known in the art and, for this reason, the brake is not further described herein. By adjusting the brake in one direction a greater restraining force is exerted on the flywheel to impede free movement of the flywheel while, by adjusting the brake in an opposing direction, the restraining force which impedes movement of the flywheel is lessened.

The axle 112 defines an output point or output axis 116 for a drive member 120 which is fixed to a protruding end of the axle.

The drive member 120 includes a hollow section 122, of rectangular dimensions, which is fixed to a protruding end of the axle 112 which extends towards the base 100, and an elongate member 124 of rectangular cross section which is complementary to the internal shape of the hollow section 122, and which is slidably located inside the hollow section.

The member 124 is formed with a number of holes 126 at spaced locations along one side and a fastener 128, fixed to the hollow section 122, can be engaged with a selected hole thereby to vary the effective length L of the drive member 120.

A handle 130 is fixed to an outer end of the member 124, which end is also referred as an input point 132 of the drive member 120, and the handle extends transversely to the member 124 so that it overlies a part of the base 100.

The arrangement and orientation of the components of the exercise machine relatively to the base are such that a user can stand on the base 100 and is able to grip the handle 130 with both hands with each hand curving around a grip portion of the handle ie. about an axis which is substantially at a right angle to the direction in which the member 124 extends.

The user can rotate the handle about the axis on which the axle 112 lies. In the process and during the rotation, depending on the effective length of the drive member 120, the user is compelled to a greater or lesser extent to bend at the knees and then to straighten the legs and reach upwardly with his arms in order to complete the rotational movement of the handle 130 about the axis on which the axle 112 lies.

The handle 130 is aligned with what is referred to herein as an input point 132 to the drive member 120. The input point is the point at which a user inputs force or effort into the exercise machine and it is rotated through a closed circular path which lies in a substantially vertically plane. In the described mode of use the user stands adjacent the closed path and generally faces in a direction which is parallel to the plane of rotation. The drive arrangement has an output point 116, aligned with the axle 112, at which the force generated by the user is transferred to the flywheel. The flywheel is rotatable against a resistance force generated by its inertia, frictional forces and the like. The primary resistance to movement, however, is generated by the brake 114 which, as noted, is adjustable.

During use of the machine, the mass of the user, who stands on the base 100, acts to stabilise the exercise machine. This is an important factor for substantial forces can be generated on the machine during use thereof, particularly if the handle is rotated vigorously.

The machine can also be used in a way which has been described in connection with Figure 1 in that a user can stand facing the flywheel and the plane in which the input point is rotated, looking basically in the longitudinal direction of the axle 112, grip the handle 130 with both hands and rotate the handle using a swaying or swinging type motion with a corresponding leg-bending and leg-straightening action, the extent of which is determined by the height of the output point above the platform and the length of the lever between the input point and the output point.

Figure 3 illustrates a defined path 140, shown in dotted outline, along which the input point 132 moves during use of the machine. In this instance the path is circular for the drive member 120 is of a fixed length (L) during the use of the machine. This is not essential for, as is described hereinafter, the path may have a shape which can be varied automatically, or dynamically in response to the exercise action of the user.

To enable maximum benefit to be derived from the machine, the length of the drive member 120 should be sufficiently great to ensure that the user must bend at the knees and then straighten the legs and raise the arms while rotating the member 120. This type of action cannot be achieved with a "bicycle-type" exercise machine in which the user alternately exerts force on a resistance device with a left arm and a right arm. With this type of machine a support structure is normally positioned between two cranks which are respectively

gripped by the user with the left hand and the right hand in a manner which causes the user's body to come close to the support structure. Clearly there is an inherent limitation to the maximum length of each crank. With the exercise machine of the invention, however, by displacing the drive arrangement to one side of the support structure, it is possible to increase the length of the drive to allow for at least two compound exercise movements each of which results in the user exercising the arms, the torso, the waist and the legs, in an aerobic manner, simultaneously.

The bicycle-type machine referred to does not include a support structure which is capable of handling a "one-sided" input of force by a user for the stability of this type of machine relies on the user being centrally positioned between the cranks so that one arm can push while the other arm pulls, and vice versa. With the machine of the invention however, the user's mass constitutes a ballast which, coupled to the cantilever-type arrangement of the base and the support structure, permits the user to stand adjacent the machine and exert force with both arms acting in unison and in the same direction.

Figure 3 shows that the defined path 140 has a maximum height X above a platform formed by the base 100 and a minimum height Y at a lowermost portion of the stroke of the handle, above the platform. The output point is a distance D above the platform and $X = D + L$ and $Y = D - L$. A particularly advantageous form of the invention is realised if the ratio of X to Y is ≥ 2. Again it is pointed out,

taking into account the height D of the output point above the platform, which typically is of the order of 1400mm (55 inches), that this degree of relative movement is not achievable using a bicycle-type arm exercise machine of a kind which is known in the art.

Figures 7 to 10 correspond respectively to Figures 3 to 6 and illustrate the exercise machine 90 as it is folded into a compact mode for storage or transport purposes. The supports 94 and 96 are pivoted towards each other and the panels 102, 104 and 106 hinge relatively to each other, about the respective pivot points 108, to provide a compact construction. The member 124 and the handle 130 can be detached, if required, from the hollow section 122 to facilitate storage. This allows different handles, eg. of the kind described hereinafter, to be used with the machine.

The gear drive mechanism 111 is shown schematically, in dotted outline, and is such that the rotational speed of the flywheel is at least 20 times the rotational speed of the axle at the output point. Thus the handle 130 rotates at a speed which is substantially less than the rotational speed of the flywheel. On the other hand movement of the flywheel is constrained, as indicated, by the brake 114. The mechanical advantage which results from this type of arrangement enables the size of the flywheel to be reduced substantially typically, as indicated, to a mass of the order of 5kg or even lower. The mechanism 111 could include an appropriate gearbox, a belt drive or any other suitable arrangement.

Figure 11 shows a machine 90A which is similar to the machine 90 and for this reason is not described in detail. Also like reference numerals are used to designate like components. A belt and pulley drive arrangement 111A, of a kind similar to that described hereinafter, is used to rotate the flywheel 110. The base 100A include three slotted panels 102A, 104A and 106A respectively which are fixed to laterally extending supports 107 and 109 respectively at lower ends of the inclined supports 94A and 96A. The panels can be moved to the planar orientation shown in Figure 11, and to a folded arrangement similar to what is shown in Figure 9, but the pivot points 108A and 108B cannot be moved downwardly below the Figure 11 position, due to interlocking formations at abutting ends of the panels, a feature which helps to stabilise the machine in use.

Figure 12 shows a drive member 120A which includes an elongate member 124A formed from two telescopically engaged parts 124X and 124Y respectively. The parts are joined by a spring 160 which is positioned inside the part 124X. In this example the axle 112 is mounted to a pulley 162 and drive is transferred to a resistance assembly, not shown, by means of a belt 164 which is engaged with the pulley. The spring tends to pull the member 124Y into the member 124X and thereby decrease the radius of a path along which the input point 132 is moved. As the rotational speed of the handles increases, however, the radius of the defined path of movement increases in a dynamic fashion influenced, inter alia, by the vigour and force with which the user exercises.

Figure 13 illustrates a drive member 120B which is similar to that shown in Figure 11 except that the spring 160 is replaced by an elastic band 160A.

Figure 14 shows a drive member 120C wherein a piston and cylinder assembly 160B replaces the spring 160. This assembly is double-acting in that forces are generated which tend to restrict movement of the piston into, and out of, the cylinder.

Another possibility is to use an elongate screw and nut arrangement, in the nature of a worm drive, to vary the length of the member. This can be done dynamically, or even automatically if use is made of a small electric motor to move the nut along the screw.

Clearly, with the arrangements shown in Figures 12 to 14, the force which is needed to rotate a flywheel can be varied dynamically, during use of the machine, without the need to stop and adjust the length of the drive member 120. In each case the input point moves along a path, which is dynamically variable, and forms a closed loop of variable shape which lies in a vertical plane.

Figure 15 shows an arrangement, for setting the drive member 120 at a fixed length, which is similar to what has been described in connection with Figures 3 to 4 in that a member 124 is movable into, or out of, a hollow section 122 which is mounted to an axle 112. At a chosen length the members 122 and 124 are

fixed to one another by engaging a pin on a fastener 128 with a corresponding hole 126 in the member 124.

The axle 112 is mounted to a pulley 162 which imparts rotational drive to the resistance assembly, not shown, by means of a belt 164.

Figure 16 shows a mechanical equivalent to the arrangement of Figure 15 which provides for continuous, as opposed to stepwise, adjustment of the distance L, i.e., the distance between the input point 132 and the output point 116. A screw 166 includes a shank 168 which extends through a slot 170 in a hollow section 122. The shank is threadedly engaged with a complementary hole in the member 124. The screw can be tightened when the member 124 is at a selected position relatively to the hollow section 122 in order to fix these components together.

Figures 17 to 19 illustrate different handle arrangements for use with the machine of the invention. In Figure 17 a handle 130, in the form of an elongate shaft, is fixed to the member 124. The handle has at least two grip portions 176 and 178, alongside one another, which enable a user to grip the handle with both hands, adjacent each other, with each hand curled around an axis 180 on which the shaft lies and which extends through the input point 132 which, upon being moved, forms the defined path or closed loop 140. The axis 180 is substantially at a right angle to a plane in which the path 140 lies.

Figure 18 illustrates an arrangement wherein a handle portion 130A is mounted via a flexible joint 182, in the nature of a universal joint, to a handle portion 130B which is immovably fixed to the elongate member 124. Clearly the handle portion 130A is movable, to a greater or lesser extent, relative to the fixed handle portion 130B during use of the exercise machine. The handle portion 130A can provide sufficient space for two grip portions 176 and 178 for the two hands of a user. It is possible to remove the handle portion 130B and connect the joint 182 directly to the member 124 as is indicated in dotted lines 124A.

Figure 19 illustrates a handle 130C which is also of compound construction. The handle 130C includes a fixed handle portion 130B which extends from the elongate member 124. A second handle portion 130D is connected to the handle portion 130B. The handle portion 130D includes a transverse component 130F which is fixed, by means of a bearing 184, to a short stub 130G which, in turn, is fixed to the handle portion 130B either immovably or by means of a universal connector 182 which allows pivotal movement of the component 130F, to a limited extent, relative to the portion 130B. The bearing allows the component 130F to rotate about the axis 180 which passes through the input point 138.

The handle arrangement shown in Figure 19 is intended to be used by a person who stands on the platform 100 looking generally in a direction which is substantially parallel to the axis 180. The component 130F has two grips 186 and 188 respectively for the left and right hands of the user. The user can impart

rotational drive to the member 124 but with the user facing the plane in which the defined path 140 lies. Again it is required of the user to bend and straighten the legs to a greater or lesser extent depending on the effective radius or length of the member 124. However the type of movement required of the user's body differs substantially from the movement required when a handle arrangement of the type shown in Figure 17 is used. With the Figure 19 arrangement, although the arms are again moved in unison, it is necessary for the user to sway the upper portion of the body to and fro and to reach upwards and downwards as the handle rotates.

Figure 20 shows a handle 130J in the form of a Z with grips 176A and 178A, which are parallel to each other and which are joined by a cross piece in the form of a bar 130K. A shaft 130L which is detachably and rotatably mounted to an input point (not shown) is coupled to a centre-point of the cross bar 130K by a universal joint 182A which allows the handle 130J to move with a pivotal action relatively to the shaft in a way which helps to reduce strain or stress on the user's arms and hands during use of the machine.

Figure 21 shows that the handle 130J can be coupled to the shaft 130L by means of strong coil spring 182B which is located on a centre line through the cross bar and which offers a degree of flexibility which is similar to that provided by the universal joint 182A.

Figure 22 shows the handle 130J connected to the shaft by a flexible and strong rubber bush 182C which permits flexibility of the handle in all directions relatively to the shaft.

Figure 23 shows a handle 130M with aligned side-by-side grips 176B and 178B detachably fixed to a drive member 120B by means of snap-fit fastener 179. The grips are rotatable around a bearing housing 181.

As stated the machine can be designed so that it can be used with any of these handles (or other suitable handles) and, in each case the particular handle which is used creates different exercise characteristics.

Figure 24 shows an exercise machine wherein a drive member 120K is formed from articulated components 122K and 124K respectively connected to an output point 116 by joints 182A and 182B of the kind described in connection with Figure 18. The effective length L of the drive member is dynamically adjustable, by the user, during use of the machine. The articulated connection allows the user to change his stance, on the platform 100, by moving his feet during use of the machine.

Figure 25 shows a machine which uses articulated joints 182C and 182D between a handle 130D of the type shown in Figure 19 and a telescopic member 120F of the type shown in Figures 12 and 13, to provide a drive, which is dynamically adjustable in length, to the output point 116.

A preferred form of the invention is one wherein the base 100, as shown in Figure 3, forms a platform upon which a user stands whilst using the machine. The user's mass then provides sufficient stabilisation to ensure that the machine is stable during use. It is however not essential to use this type of construction and, in a more permanent arrangement, the support structure 92 can include a small pedestal 190 which can be fixed to the floor 194, as is shown in Figure 26. Figure 27 shows that the support structure 92 can include formations 196 eg. in the form of a spreader plate or connecting bar whereby the exercise machine can be attached, using suitable fasteners, to a wall 198.

Clearly with the arrangements shown in Figures 26 and 27 it is not possible for the machine to be dismantled with ease for storage or transport purposes.

It is also to be noted, referring to Figures 24 to 27, that a "step-up" drive system can be employed for increasing the rotational speed of the axle 112 which forms the output point of the drive arrangement 120. Referring for example to Figure 27 the axle 112 is mounted to a pulley 162 which transfers drive via a belt 164 to a relatively smaller pulley 162A. The smaller pulley drives a larger pulley 162B which is connected to another smaller pulley 162C by means of a second belt 164A. A flywheel 110 which includes a brake 114 is fixed to the support structure 92 and is driven by an output shaft from the pulley 164C.

Figure 28 illustrates from the side an arrangement which is similar to what has been described in connection with Figure 27 except that the support structure 92 extends upwardly from a base 100 which rests on the ground and is not fixed to the wall.

As used herein the word "axle" or "axis" is intended to include an actual axle and axis, as the case may be, and also a virtual axle or axis. The phrase "virtual axle or axis" is intended to cover a situation in which rotational movement takes place about a point which does not define a physical axle or axis, but merely a centre of rotation. This type of arrangement is shown in Figures 29 and 30 respectively which illustrate an exercise machine similar to what has been described in connection with Figure 28, wherein the support structure 92 supports a circular support frame 200. A wheel 202 is mounted inside the circular support frame and runs on rollers 204 which are fixed at spaced locations to the wheel. The rollers in turn ride inside a hollow guide or track, on an inner surface of the support frame, indicated in dotted outline 206.

A pulley 162 is fixed to a central point on the wheel 202. The pulley drives a belt 164 which, in turn, drives a smaller pulley 162A which is mounted to a larger pulley 164B. The pulley 164B drives a belt 164A which is connected to a smaller pulley 164C which drives a flywheel 110 to which is fitted a brake 114. It can be seen that the arrangement in Figures 29 and 30 is similar to what has been described in connection with Figure 27 except that the wheel

202, riding inside the support frame 200, simulates a fixed axle by providing a virtual axle 216 which defines the output point of the drive member 120.

In this example the drive member includes a plate 220 which normally is fixed to, and covers, the wheel 202 and which is formed with a number of holes 222 at spaced intervals extending from the virtual axis 216. A handle 224 can be engaged with a selected hole which defines the input point 132. The user can, as before, grip the handle with both hands and cause it to rotate along a defined circular path centred on the virtual axis 216 which coincides with the output point 116. A step-up drive is achieved to the flywheel which is braked, to a required extent, by the brake 114. In all other respects the operation of the exercise machine is substantially the same as what has been described.

Figure 31 shows a compound machine which, in many respects, is similar to that shown in Figure 2, and which is basically a combination of two machines 90F and 90G each of which is similar to the machine 90 in Figure 3. Each machine has its own flywheel. The handles 130F and 130G of the machines can be joined by a coupling bar 230 or they can be displaced to form a gap 232 between the handles which can accommodate a user. If the handles are not joined they can be angularly displaced by up to 180°, as shown by dotted lines for the handle 130G. These features allow for a multitude of different types of usage.